UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/735,494	12/12/2003	Paul Douglas Yoder	51527/SAH/T539	1869

7590 09/21/2005

CHRISTIE, PARKER & HALE, LLP
P.O. BOX 7068
PASADENA, CA 91109-7068

EXAMINER	
DICKEY, THOMAS L	
ART UNIT	**PAPER NUMBER**
2826	

DATE MAILED: 09/21/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/735,494	YODER, PAUL DOUGLAS	
	Examiner	Art Unit	
	Thomas L. Dickey	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 August 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28 and 30-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *15-18* is/are allowed.

6)☒ Claim(s) *1-14,19,24,25,27,28,30,31 and 33-35* is/are rejected.

7)☒ Claim(s) *20-23,26 and 32* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Minhloan Tran
Minhloan Tran
Primary Examiner
Art Unit 2826

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 December 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. The amendment filed on 08/10/2005 has been entered.

Information Disclosure Statement

2. If applicant is aware of any relevant prior art, he/she requested to cite it on form **PTO-1449** in accordance with the guidelines set forth in M.P.E.P. 609.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter, which the applicant regards as his invention.

Claims 6 and 25 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claims 6 and 25 the phrase "further comprising a charge layer formed of InAlAs and interposed between said graded transition region and said InAlAs multiplication layer" renders the claim indefinite insofar as base claims 1 and 19 already have introduced a charge layer interposed between said absorption layer and said multiplication region and formed of substantially the same material as a first multiplication layer. Claims 6 and 25 will be examined under the assumption that applicant intended to recite –wherein said charge layer and said multiplication layer are

formed of InAlAs– in place of "further comprising a charge layer formed of InAlAs and interposed between said graded transition region and said InAlAs multiplication layer."

Correction is required.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1,5,7-10,19,20,27,28, and 30 are rejected under 35 U.S.C. 102(e) as being anticipated by KO ET AL. (2004/0251483).

With regard to claims 1,5, and 7-10 Ko et al. discloses an avalanche photodetector comprising an absorption layer 20, a multiplication region 24 including at least one multiplication layer, a charge layer 22 interposed between said absorption layer 20 and said multiplication region 24 and formed of substantially the same material as a first multiplication layer disposed adjacent said charge layer 22, and an InGaAlAs graded transition region 18B including at least two cations (Ga and Al) including molar fractions that vary throughout said graded transition region 18B to effectuate a graded bandgap material, and formed of In, Ga, Al and As between said absorption layer 20 and said

multiplication region 24, said graded transition region 18B including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said absorption layer 20 and a second conduction band energy level of said multiplication region 24, in which said graded transition region 18B is a film having a top facing said absorption layer 20 and a bottom facing said multiplication region 24 and a ratio of Al:Ga varies gradually such that Ga concentration is maximized and Al concentration is minimized at said top, and Ga concentration is minimized and Al concentration is maximized at said bottom, so that said graded transition region 18B comprises essentially InGaAs at said top and InAlAs at said bottom. Note figures 1-8 and paragraphs 24-29 of Ko et al.

With regard to claims 19,20,27, and 28 Ko et al. discloses an avalanche photodetector comprising an absorption layer 20 having a top and a bottom, a multiplication region 24 disposed facing said bottom and including at least one multiplication layer and a charge layer 22 interposed between said absorption layer 20 and said multiplication region 24 and formed of substantially the same material as a first multiplication layer disposed adjacent said charge layer 22, said absorption layer 20 including a P-type impurity therein, and a P-type impurity concentration gradient such that said P-type impurity concentration decreases from said top to said bottom, further comprising a graded transition region 18B disposed between said absorption layer 20 and said multiplication region 24, said graded transition region 18B being a graded-bandgap material, including a graded conduction band energy level that produces a gradual change between a first

conduction band energy level of said absorption layer 20 and a second conduction band energy level of said multiplication region 24, wherein said absorption layer 20 is formed of InGaAs. Note figures 1-8 and paragraphs 24-29 of Ko et al.

With regard to claims 28 and 30 Ko et al. discloses an avalanche photodetector comprising an absorption layer 20, a multiplication region 24 and a charge layer 22 including dopant impurities therein to produce an abrupt step in electric field strength disposed between said multiplication region 24 and said absorption layer 20, said multiplication region 24 consisting of only two multiplication layers including a first multiplication layer formed of a relatively wide bandgap material and disposed closer to said absorption layer 20 and a second multiplication layer formed of a relatively narrow bandgap material and disposed further from said absorption layer 20, said first multiplication layer and said second multiplication layer having a combined thickness of at least 0.1 microns, wherein said first multiplication layer is formed of substantially the same material as said charge layer 22. Note figures 1-8 and paragraphs 24-29 of Ko et al.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-14, 19,24,25,27,28,30,31, and 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over BARROU ET AL. (5,912,478) in view of Ko (2005/0029541).

With regard to claims 1-14 Barrou et al. discloses an avalanche photodetector comprising an InGaAs absorption layer 20, a multiplication region 14 including at least one multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24), and a graded transition region 16 between said InGaAs absorption layer 20 and said multiplication region 14, said graded transition region 16 including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said InGaAs absorption layer 20 and a second conduction band energy level of said multiplication region 14, in which a potential energy difference between said InGaAs absorption layer 20 and said multiplication region 14, is about 0.475 eV (Note that InGaAs has a bandgap of about .8 eV, while InGaAlAs, the material of the "well" multiplication layer, has a bandwidth of about 1.275 eV), said graded transition region 16 is formed of a graded-bandgap material having a wider bandgap region closer to said multiplication region 14 and a narrower bandgap region closer to said InGaAs absorption layer 20, said graded transition layer is formed of InGaAlAs and said InGaAlAs is a graded bandgap material in which a ratio of at least two cations (Ga and Al) of said InGaAlAs varies within said graded bandgap material, said graded transition region 16 is formed of In, Ga, Al and

As, said InGaAs absorption layer 20 is formed of InGaAs and in which said multiplication region 14 is composed of two multiplication layers being an InAlAs multiplication layer disposed closer to said graded transition region 16 and an InGaAlAs multiplication layer disposed further from said graded transition region 16 and further comprising a charge layer formed of InAlAs and interposed between said graded transition region 16 and said InAlAs multiplication layer, said graded transition region 16 is a film having a top facing said InGaAs absorption layer 20 and a bottom facing said multiplication region 14 and a ratio of Al:Ga varies gradually such that Ga concentration is maximized and Al concentration is minimized at said top, and Ga concentration is minimized and Al concentration is maximized at said bottom, said graded transition region 16 comprises essentially InGaAs at said top and InAlAs at said bottom, or in which said graded transition region 16 may be InGaAlAs, a quarternary material, said quarternary material includes at least two cations (Ga and Al) (Ga and Al) including molar fractions that vary throughout said quarternary material to effectuate a graded bandgap material, said graded transition region 16 includes a thickness and an un-biased effective electric field is defined as the difference of said first conduction band energy level and said second conduction band energy level divided by said thickness, and further comprising an applied bias applied across said avalanche photodetector, said thickness and said applied bias chosen such that said applied bias exceeds said un-biased effective electrical field by at least 20 kV/cm, or in which said graded transition region 16

includes a thickness within the range of 500A to 0.4 microns, and further comprising a power supply coupled to said avalanche photodetector and capable of providing a bias thereacross. Note figures 1-4 and column 4 lines 10-55 of Barrou et al. Barrou et al. does not disclose a charge layer having essentially said second conduction band energy level and interposed between said graded transition region 16 and said multiplication region, said charge layer including dopant impurities therein to produce an abrupt step in electrical field strength, and interposed between said absorption layer and said multiplication region and formed of substantially the same material as a first multiplication layer disposed adjacent said charge layer.

However, Ko discloses an avalanche photodetector comprising a charge layer having essentially said second conduction band energy level and interposed between a graded transition region 22 and a multiplication region 18, said charge layer 20 including dopant impurities therein to produce an abrupt step in electrical field strength, and interposed between an absorption layer 24 and said multiplication region 18 and formed of substantially the same material as a first multiplication layer 18 disposed adjacent said charge layer 20. Note figure 1 and paragraphs 0010-0014 of Ko. Charge layer 20, according to Ko, optimizes the photoconductive structure of the avalanche photodiode (APD) for increased performance. Therefore, it would have been obvious to a person having skill in the art to replace the charge layer of Barrou et al.'s avalanche photodetector with the charge layer having essentially said second conduction band energy level and interposed between a graded transition region and a multiplication

region, said charge layer including dopant impurities therein to produce an abrupt step in electrical field strength, and interposed between a absorption layer and said multiplication region and formed of substantially the same material as a first multiplication layer disposed adjacent said charge layer, such as taught by Ko in order to optimize the photoconductive structure of the avalanche photodiode to thus provide increased performance.

With regard to claims 19,24,25, and 27 Barrou et al. discloses an avalanche photodetector comprising an InGaAs absorption layer 20 having a top and a bottom, a multiplication region 14 disposed facing said bottom and including at least one multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24), said InGaAs absorption layer 20 including a P-type impurity therein, and a P-type impurity concentration gradient such that said P-type impurity concentration decreases from said top to said bottom, further comprising a graded transition region 16 disposed between said InGaAs absorption layer 20 and said multiplication region 14, said graded transition region 16 being a graded-bandgap material, including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said InGaAs absorption layer 20 and a second conduction band energy level of said multiplication region 14. Note figures 1-4 and column 4 lines 10-55 of Barrou et al. Barrou et al. does not disclose an InAlAs charge layer interposed between said absorption layer and said

multiplication region and formed of substantially the same material as said first InAlAs multiplication layer disposed adjacent said charge layer, including dopant impurities therein.

However, Ko discloses an avalanche photodetector comprising an InAlAs charge layer 20 interposed between an absorption layer 24 and a multiplication region 18 and formed of substantially the same material as the first InAlAs multiplication layer (in region 18) disposed adjacent said charge layer 20, including dopant impurities therein. Note figure 1 and paragraphs 0010-0014 of Ko. Charge layer 20, according to Ko, optimizes the photoconductive structure of the avalanche photodiode (APD) for increased performance. Therefore, it would have been obvious to a person having skill in the art to replace the charge layer of Barrou et al.'s avalanche photodetector with the InAlAs charge layer interposed between an absorption layer and a multiplication region and formed of substantially the same material as a first InAlAs multiplication layer disposed adjacent said charge layer, including dopant impurities therein, such as taught by Ko in order to optimize the photoconductive structure of the avalanche photodiode to thus provide increased performance.

With regard to claims 28 and 30-35 Barrou et al. discloses an avalanche photodetector comprising an InGaAs absorption layer 20, and a multiplication region 14 said multiplication region 14 consisting of only two multiplication layers including a first InGaAlAs multiplication layer formed of a relatively wide bandgap material (Note that

InGaAs has a bandgap of about .8 eV, while InGaAlAs, the material of the "wide" multiplication layer, has a bandwidth of about 1.275 eV) and disposed closer to said InGaAs absorption layer 20 and a second (InGaAs) multiplication layer formed of a relatively narrow bandgap material and disposed further from said InGaAs absorption layer 20, said first multiplication layer and said second multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24) having a combined thickness of at least 0.1 microns, further comprising a graded transition region 16, said graded transition region 16 being a graded-bandgap material including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said InGaAs absorption layer 20 and a second conduction band energy level of said first multiplication layer; wherein said first multiplication layer is formed of InAlAs, said second multiplication layer is formed of InGaAlAs, and said InGaAs absorption layer 20 is formed of InGaAs, said InGaAs absorption layer 20 includes a top and a bottom facing said multiplication region 14 and includes a P-type impurity therein, said InGaAs absorption layer 20 including a P-type impurity concentration gradient decreasing from said top to said bottom, and each of said first multiplication layer and said second multiplication layer includes a thickness of at least 0.1 micron. Note figures 1-4 and column 4 lines 10-55 of Barrou et al. Barrou et al. does not disclose an InAlAs charge layer disposed between said multiplication region and said absorption layer, and between said and said absorption layer, wherein said first multiplication layer is formed

of substantially the same material as said charge layer and includes dopant impurities therein to produce an abrupt step in electric field strength.

However, Ko discloses an avalanche photodetector comprising an InAlAs charge layer 20 disposed between a multiplication region 18 and an absorption layer 24, and between said and said absorption layer 24 and a graded transition region 22, wherein the first multiplication layer (in region 18) is formed of substantially the same material as said charge layer 20 and includes dopant impurities therein to produce an abrupt step in electric field strength. Note figure 1 and paragraphs 0010-0014 of Ko. Charge layer 20, according to Ko, optimizes the photoconductive structure of the avalanche photodiode (APD) for increased performance. Therefore, it would have been obvious to a person having skill in the art to replace the charge layer of Barrou et al.'s avalanche photodetector with the InAlAs charge layer disposed between a multiplication region and an absorption layer, and between said and said absorption layer and a graded transition region, wherein said first multiplication layer is formed of substantially the same material as said charge layer and includes dopant impurities therein to produce an abrupt step in electric field strength, such as taught by Ko in order to optimize the photoconductive structure of the avalanche photodiode to thus provide increased performance.

Allowable Subject Matter

6. Claims 20-23,26 and 32 are objected to as being dependent upon a rejected base claims, but would be allowable if rewritten in independent form including all of the limitations of their respective base claims and any intervening claims.

7. Claims 15-18 are allowed over the references of record because none of these references disclosed or can be combined to yield the claimed invention such as an APD having, in addition to a multiplication region and a first multiplication layer (i.e. two multiplication parts), a charge layer is interposed between said multiplication region and a absorption layer having a P-type dopant impurity with an "x" gradient such that $\partial \ln N/\partial x \geq 3$ K eV /cm (0.3 eV/micron) divided by kT, where k is the Boltzmann constant, T represents operating temperature of said photodetector in degrees Kelvin, q is the fundamental unit of charge, N represents concentration of said P-type dopant impurity, and x represents distance from one of the top and bottom of the absorption layer, as recited in claim 15.

Response to Arguments

8. Applicant's arguments with respect to claims 1-14, 19,24,25,27,28,30,31, and 33-35 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas L. Dickey whose telephone number is 571-272-1913. The examiner can normally be reached on Monday-Thursday 8-6.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J. Flynn can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status

information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TLD
09/05